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Rural Farmers' Perception of Climate Change in Rice-Wheat Cropping System

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ABSTRACT

The farmers had perceptions that contribute to climate change dimensions such as increase in temperature, unpredictable and irregular rainfall trends, increased intensity of heat during summer. The study was conducted by survey method in Adaptive Research Gujranwala, Pakistan zone during year 2020. Four tehsils of the said zone were randomly included in sampling frame. Then to select the respondent farmers, convenience non-probability sampling method was employed. A well-structured and pretested questionnaire was used for data collection from 100 respondent farmers. The data were analyzed with descriptive statistics and linear regression model. The value of R^2 implies that 67% of the variations in the perception of the farmers were explained by the independent variables like education, farming experience and farm size. The identified causes of climate change were ranging from soil degradation and erosion, intensified agriculture to increased use of chemical fertilizer & fossil fuel etc. Many of the farmers adapted to climate change by strategies like planting trees, carrying out soil conservation practice, changing planting dates and using different crop varieties. 35% of the farmers did not adapt any strategy to climate change. Extension services should carry out massive campaign on tree planting, soil conservation practices and updated production technology of crops as it contributes to climate change.

Keywords: Gujranwala, climate change, farmers, perception, rice

INTRODUCTION

Climate change has become a great challenge for the agrarian economy of Pakistan. A serious threat is to the crop sector which is vulnerable to change in temperature and rainfall. Climate change refers to any change in climate overtime, whether due to natural variability or as a result of human activity (Change, 2001). The climate conditions prevailing within the top soil and atmosphere influence the growth and performance of crops (Ayoade 2002). The rains these days are unpredictable. The world's average temperature has increased since the last century (Shah and Ameta 2008). This is leading to rising sea surface and drastic changes in rainfall patterns, affecting the production potential of rural areas. According to Winarto *et al*. (2008), farmers have always responded to climate change with respect to their choice of crops, crop varieties, planting, and other cultural measures.

Rural is an area of settlement in which more than half of the adult population is engaged in farming. Perceptions not only shape the knowledge but knowledge also shapes perception. Farmers' perceptions about climate change, therefore, strongly affects how they deal with climate induced risks and uncertainties, and undertake specific measures by coping strategies to mitigate the adverse impact of climate change on agriculture.

There are many cultural adaptations that have been suggested in various literatures. These include crop diversification and timing of operations, income diversification, development and promotion of new crop varieties, and improvement of water management techniques (Deressa *et*

al. 2009).

The major objective of the study was to analyze farmers' perception of climate change and examine its relationship to socio-economic characteristics of farmers. Specifically the study aimed to estimate the awareness of rural farmers on climate change, the farmers' perception of the causes of climate change, and the effects of climate change on crops as perceived by them. The hypothesis of the study was that the socio-economic characteristic variables such as level of formal education, farming experience and farm size do not affect farmers' perception of climate change.

MATERIAL AND METHODS

The survey study was conducted in Adaptive Research Gujranwala zone, Govt. of the Punjab, Pakistan during year 2020. Among the 20 tehsils of the said zone 04 tehsils such as Gujranwala, Nowshehra Virkan, Wazirabad and Kamoke were randomly included in the sampling frame. The soil and climate of the region is favorable for the cultivation of wheat, rice, berseem, sugarcane, maize, oil seeds and fodders but the general crop rotation is rice-wheat. Basmati rice is the principal crop in the Khraif (June-November) season and occupies about 25% of the total cropped area in the season. Wheat is a major staple crop of the Rabi (November-April) season and occupies 75% of the cultivated area in Rabi season (Latif et al., 2018).

To select the respondent farmers, convenience non-probability sampling method was adopted due to time and cost constraint. Thus twenty five farmers from each tehsil of selected district making a total of 100 respondent farmers were interviewed. A well-structured and pretested questionnaire was employed for data collection.

The data collected were subjected to descriptive statistical analysis such as frequently counts, percentage and mean derived from four point Likert's type scale as the following: 4 = strongly agree, 3 = agree, 2 = disagree, and 1 = strongly disagree. The Likert's scale was done by asking some statements. To which the responses were rated according to their perceptions and the cut-off mean score was determined by adding the ratings up (4 + 3 + 2 + 1 = 10) and dividing the sum by 4 to give 2.5 as the cut-off mean score. For each statement, the total score was divided by the number of respondents, for instance a statement like "Rains are occurring either earlier or later than the expected rainy season" may have responses of strongly agree (*f*= 70); agree (*f* = 26); disagree (*f* = 4) and strongly disagree (*f* = 0). It will now be worked as 70 x 4 = 280, 26 x 3 = 78, 4 x 2 = 8 and 0x 1 = 0. Then 280 + 78 + 8 + 0 = 366. The sum was divided by the total *f* thus, 366/100 = 3.66. In this case, 3.66 was the mean score which is greater than the cut-off mean score of 2.50. The ranking was done according to the mean values, with the one with the highest mean ranking '1'.

The hypothesis was subjected to analysis using linear regression model. The hypothesis states that the socioeconomic characteristics of respondents such as farm size, level of formal educational attainment and farming experience do not affect farmers' perception of climate change, and it is expected that these variables will affect their perception. The same methodology was adopted by Ofuoku and Campus (2011). The implicit form of the model for the regression analysis was given below:

$Y = f(X1, X2, X3, U)$

Where Y = Perception (total Likert's type scale of each respondent)

X1 = Education (number of years of schooling)

X2 = Farming experience (years)

X3 = Farm size (ha)

U = Error term

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

The average age (year) and education (schooling year) of respondent farmers were estimated at 41.50

and 8.06, respectively. The average land holding size was recorded as 4.21 ha while prevailing land rent was found as 92.45 thousand Rs ha^{-1}. In studied area, the soil type was estimated as sandy (20%), clayey (34%) and clayey loam (46%) and source of irrigation was recorded as canal (15%), tubewell (75%) and combined (10%).

Farmers' perception of change in climate factors

The farmers perceived the climate change dimensions and recorded their response rank wise with highest to lowest response on the statements such as rains are occurring either earlier or later than the expected rainy season, intensity of heat during summer has increased, increase in temperature and number of sunny days, duration of dry spell during rainy season has increased, decrease in ground water table, bitterness of cold during winter has increased, increase in frequency of heavy rains, total rainy days have decreased and number of sunshine hours during rainy season have decreased increase in amount of rainfall (mm) (Table 1). The survey findings are in accordance to Ansari et al., (2018).

Table 1: Climate change dimensions as perceived by farmers

Climate change dimensions	Mean	Rank
Bitterness of cold during winter has increased?	3.60	6
Decrease in ground water table	3.66	5
Duration of dry spell during rainy season has increased?	3.66	4
Increase in amount of rainfall (mm)	3.08	10
Increase in frequency of heavy rains	3.41	7
Increase in Temperature and number of sunny days	3.66	3
Intensity of heat during summer has increased?	3.73	2
Number of sunshine hours during rainy season have decreased	3.14	9
Rains are occurring either earlier or later than the expected rainy season?	3.88	1
Total rainy days have decreased?	3.37	8

Cut-off score = 3.0 (> 3.0 = important cause, < 3.0 = not important cause).

Causes of climate changes as perceived by farmers

The farmers perceived use of chemical fertilizer, soil degradation and erosion, population explosion, loss of indigenous knowledge practice, intensified agriculture, increased use of fossil fuel, gas flaring and deforestation as being causes of climate change (Table 2).

Table 2: Causes of climate changes as perceived by farmers

Causes of climate changes	Mean	Rank
Use of chemical fertilizer	3.71	4
Soil degradation and erosion	3.92	1
Population explosion	3.06	8
Loss of indigenous knowledge practice	3.14	7
Intensified agriculture	3.81	2
Increased use of fossil fuel	3.66	5
Gas flaring	3.77	3
Deforestation	3.52	6

Cut-off score = 3.0 (> 3.0 = important cause, < 3.0 = not important cause).

Ofuoku (2011) further argued that this is mainly due to change in land use patterns in intensified agriculture coupled with deforestation, soil degradation and erosion. Deforestation and erosion result in considerable quantities of carbon dioxide being released into the atmosphere, a total complemented by the production and use of fertilizer.

Effects of climate change

The farmers' perception of the effects of climate change included the statements such as the attack of disease appearance earlier/later than normal days, the change in cropping pattern, the change in varietal adoption increased, the changes in planting timing and the length of growing season for crops,

the emergence of new weeds (like *Liptochloa chinensis etc.),* the increase in the intensity of soil salinity, the increased pest and the disease out break, the intensity/emergence of human disease increased (like covid-19), the poor quality of safe drinking water, the reduction in crop yield and the spikelet sterility in rice due to temperature increase during anthesis (Table 3). Shah and Ameta (2008) agued that this is directly linked to reduced soil productivity and high incidence of pests and diseases. This is also directly linked to reduced performance of livestock. These effects have serious implications for food security for the study area, especially the rural communities which also rely on agriculture to meet their subsistence needs. These findings support Mertz *et al*. (2009) who observed that farmers attribute these challenges aforementioned to climate.

Table 3: Farmers' perception of the effects of climate change

Effects of climate change	Mean	Rank
Attack of disease appearance earlier/later than normal days	3.66	2
Change in cropping pattern	3.51	6
Change in varietal adoption increased	3.19	8
Changes in planting timing and length of growing season for crops	3.64	3
Emergence of new weeds (like *Liptochloa chinensis* etc.)	3.32	7
Increase in the intensity of soil salinity	3.12	11
Increased pest and disease out break	3.59	4
Intensity/emergence of human disease increased (like covid-19)	3.17	9
Poor quality of safe drinking water	3.79	1
Reduction in crop yield	3.57	5
Spikelet sterility in rice due to temperature increase during anthesis	3.17	10

Cut-off score = > 3.0 = important effect; < 3.0 = unimportant effect

Adaptation strategies of farmers

The results indicated that many of the farmers (35%) had not adapted any strategy to mitigate the climate change (Table 4). Those who adapted to climate change conducted various adaptation strategies such as planting trees, changing planting dates, irrigation, applying soil conservation (e.g. zero tillage wheat sowing etc.), using heat/disease tolerant varieties, more prayers to Allah/paying of *usher*, and wise & balanced fertilizer use. These findings are in accordance to Bradshaw *et al*. (2004), Maddison (2006), Hassan and Nhemachena (2008), Deressa *et al*. (2009) in their various studies.

Table 4: Farmers' adaptation strategies to climate change

Characteristics	Percentage
No adaptation	35
Planting trees	15
Changing planting dates	14
Irrigation	10
Applying soil conservation (e.g. zero tillage wheat sowing etc.)	7
Using heat/disease tolerant varieties	7
More prayers to Allah/Paying of Ushar	7
Wise & balanced fertilizer use	5

Factors affecting farmers' perception of climate change

The research findings revealed the R^2 value of 0.674. This simply implied that 67% of the variations in the perception of the farmers were explained by the independent variables included in the linear regression model. The F-ratio was also good statistically, which attests to the fact that the model fits the data. Level of education, farming experience and farm size were statistically significant and positively correlated with perception of climate change, while correlation of farm size was not

significant (Table 5). These results are in accordance with an earlier expectation that the variables will positively affect farmers' perception of climate change. Therefore, the nul hypothesis is rejected. These imply that increase in these variables will lead to enhance the perception of climate change among the farmers. This is congruent with a priori expression.

The level of education, farming experience and farm size enhanced their perception of climate change. This implies that a unit increase in the number of years of schooling would lead to about 1% increase in the probability of appreciation of climate change. A unit increase in the farming experience would lead to about 2% increase in the probability of appreciation of climate change. Similarly, a unit increase in the farm size would lead to about 5% increase in the probability of appreciation of climate change.

Table 5: Factors affecting farmers' perception of climate change

Socio-economic characteristic	Coefficient	t-value
Constant	74.02	18.053*
X1 Level of education	0.137	1.862*
X2 Farming experience	0.201	2.085*
X3 Farm size	0.551	0.536

** = significant at 5% level. F-ratio = 12.43, F-table = 2.65, R^2 = 0.674.*

According to Gbetibouo (2009), educated farmers are more likely to see that rainfall does have a significant trend of long term changes. Similarly farm experience and farm size positively influenced the perception about climate change.

CONCLUSION

The farmers had logical understanding of various dimensions that contribute to climate change such as increase in temperature, unpredictable and irregular rainfall trends, increased intensity of heat during summer, decrease in ground water table and several others. However, the major farming community had not adopt any strategy to mitigate the adverse effects of climate change due to lack of money, insufficient land, insufficient labor supply, and poor potential for irrigation. Extension services should carry out massive campaign on tree planting, soil conservation practices and dissemination of updated production technology of crops as it contributes to climate change.

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